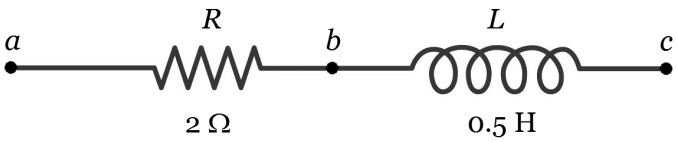
PHYS 2212
Recitation 11 April 12–15

Example
At this instant in the circuit segment shown below a current of 5 A flows to the right. If the potential difference $V_c - V_a = +10\,\text{V}$, at what rate is the current changing? Is the current increasing or decreasing?

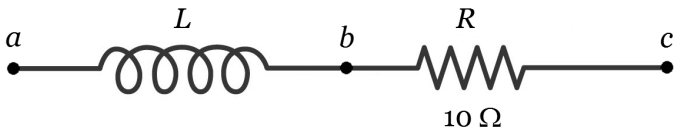


PHYS 2212 Section: _____ Name: _____

Recitation 11 April 12–15

Problem

At this instant in the circuit segment shown below a current of 3 A flows to the right. The magnitude of the current is increasing at a rate of 10 A/s. If the potential difference $V_c - V_a = -50\,\text{V}$, what is the power rating of the inductor at this instant? Is the inductor releasing or absorbing energy?



PHYS 2212 **Solution**
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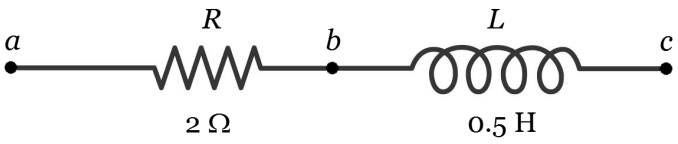

Current is flowing to the right, so the potential difference $V_b - V_a < 0$. More specifically

$$V_b - V_a = -IR = -(5\,\text{A})(2\,\Omega)$$

$$V_b - V_a = -10\,\text{V}$$

This means that $V_c - V_b = +20\,\text{V}$. This is simply the potential difference across the inductor, so:

$$|V_c - V_b| = 20\,\text{V} = L\left|\frac{dI}{dt}\right|$$

$$20\,\text{V} = (0.5\,\text{H})\left|\frac{dI}{dt}\right|$$

$$\boxed{40\,\frac{\text{A}}{\text{s}} = \left|\frac{dI}{dt}\right|}$$

Note that $V_c - V_b > 0$, so the inductor is creating an emf that tends to push current to the right. Since the current is directed to the right and inductors oppose changes in current, we can conclude that the magnitude of the current is decreasing.

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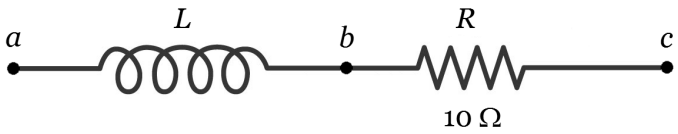

Current flows to the right so:

$$V_c - V_b = -IR = -(3A)(10\Omega) = -30V$$

$$V_b - V_a = (V_c - V_a) - (V_c - V_b) = -50V + 30V$$

$$V_b - V_a = -20V$$

The inductance of the inductor is then:

$$|V_b - V_a| = 20V = L\left|\frac{dI}{dt}\right| = L\left(10\,A/s\right)$$

$$2\,H = L$$

The power rating of the inductor is given by

$$P = \frac{dU}{dt} = \frac{d}{dt}\left(\frac{1}{2}LI^2\right) = LI\frac{dI}{dt} = IV_L$$

$$P = (3A)(20V)$$

$$\boxed{P = 60\,W}$$ absorbing (removing energy from circuit)